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STRUCTURE OF FINANCIAL SAVINGS DURING INDIAN ECONOMIC REFORMS

Raghbendra Jha
ASARC, Division of Economics
The Australian National University, Canberra

Ibotombi S. Longjam
IGIDR, Mumbai, India

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Structure of Financial Savings during Indian Economic Reforms*

Raghbendra Jha,
ASARC, Division of Economics,
Research School of Pacific and Asian Studies,
Australian National University,
Canberra, ACT 0200, Australia

Ibotombi S. Longjam,
American Express,
World Wide Risk & Information Management,
Gurgaon, 122001, India

ABSTRACT

This paper conducts nonparametric tests to examine whether data on financial savings in India can be rationalized in terms of a utility function of a representative economic agent. The nonparametric test has an advantage over its parametric counterpart in that it does not assume the existence of a utility function *per se* and checks whether the representative consumer's demand structure can at all be rationalized by a utility function. Our test results of the necessary and sufficient conditions of the weak separability hypothesis suggest that data on financial savings in India are consistent with the existence of a utility function for a representative individual with a sub-preference where contractual savings (insurance and provident funds) can be separated out. This result could facilitate the construction of a suitable financial aggregate using these assets.

Keywords: Non-parametric estimation, financial assets, India
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All correspondence to:

Prof. Raghbendra Jha,
Australia South Asia Research Centre,
Australian National University,
Canberra, Australia 0200

Phone: + 61 2 6125 2683
Fax: + 61 2 6125 0443
Email: r.jha@anu.edu.au

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I. Introduction

As an economy develops the structure of its savings plays a crucial role in determining the kinds of investments that will be financed by incremental savings. In a primitive, self-sufficient economy savings are primarily in physical assets such as land. As the financial system matures, the role of financial intermediation becomes critical in guiding savings into more immediately productive investments and is particularly relevant in developing and transition economies that have hitherto been controlled and are undergoing rapid transformation through a program of structural reforms. An understanding of the structure of savings is therefore pertinent both for increasing the volume of aggregate savings (to garner resources for higher economic growth) as well as affecting their composition (towards more productive instruments). Central to this is our understanding of the microeconomic foundations for savings behaviour, i.e., the households' demand for these assets (and the implied utility function) as they choose among various financial assets.

This paper addresses this question in the context of the Indian economy. The Indian economy has undergone rapid financial sector reform in recent years (RBI 2003) and has, as a consequence, experienced considerable change in the composition of assets available for investment. India's financial sector reforms during the 1990s have included (i) decontrolling interest rates for banks and non bank financial institutions, (ii) repeated reductions in the cash reserve ratio and the statutory liquidity ratio (mandated investment by banks in government securities), (iii) abolition of lending rates on large loans and granting banks considerable freedom in sending lending rates as well as deposit rates; (iv) gradual introduction of competition in the banking sector by permitting entry of private domestic and foreign banks and granting autonomous states to public sector banks and permitting most banks to raise capital from stock markets; (v) development of securities markets for both central and state government bonds; (vi) enhancing of capital adequacy measures; (vii) deepening of credit markets including credit cards, home loans and rural credit; (viii) enhancing scope of money market instruments such as repo and repo auctions; and (ix) improving the conduct of monetary policy by eliminating automatic central bank financing of the fiscal deficit, permitting the convertibility of the rupee on the current account and developing a robust market-based regulatory regime for all financial markets. Fiscal reforms such as reduction in top marginal income and corporate tax rates and rationalisation and simplification of tax structures accompanied the financial sector reforms. These reforms coupled with higher economic growth in the 1990s resulted in more rapid growth of financial savings as well as increased variations in their components. This paper investigates the important question of whether, in the face of such widespread financial reforms, financial savings can be rationalized in terms of the behaviour of a rational economic agent.

There exist two approaches to modelling the demand side of financial assets: a) parametric, and b) non-parametric. For the parametric case Longjam (2003) modelled the translog and Fourier functional forms and conducted tests for weak separability. However, this estimation was inconclusive since it was revealed that some rejections of the demand systems could be rejections of flexible forms or the theory itself. Furthermore this approach permits only a joint test of weak separability and functional form. This makes the functional form untestable so that it is taken essentially on faith (Varian 1982). As Swofford and Whitney (1994) point out, this is a serious matter when it comes to testing for weak separability (and establishing the relevant financial aggregate). Barnett and Choi (1989) find the specifications of the flexible functional forms to be very unreliable for the testing of weak separability.

Unlike the parametric approach the non-parametric approach does not assume the existence of a utility function *per se* and checks whether the representative consumer's demand structure can at all be rationalized by a utility function. A subsequent question is whether this utility function is weakly separable between some assets. The nonparametric approach has the further advantage over the parametric approach that it does not need a long data series for estimation. This is important in our context since the number of observations we have (particularly post-reform) is small compared to what we would like to have for a (parametric) demand study.

We follow the nonparametric tests based on the revealed preference theorem, developed over the years by Samuelson (1938), Houthakker (1950), Afriat (1967) and Varian (1982) and more recently by Swofford and Whitney (1994) and implement non-parametric tests of weakly separable preference structure (Varian 1985) and test for the necessary and sufficient conditions of the weak separability hypothesis using the method of Swofford and Whitney (1994).

The paper is organised as follows. In section II we outline the methodology adopted in the nonparametric approach. Section III presents and discusses the empirical results and section IV concludes.

II. The Nonparametric Approach – Methodology

The non-parametric approach solves the following optimisation problem for a representative economic agent

$$\text{Max}\, U(x_{1t}, x_{2t}, ..., x_{nt}),\ i = 1, 2, .., n \tag{1}$$

subject to $\pi_{it}x_{it} = F_t$ where x_{it} and π_{it} are, respectively, the i^{th} financial asset and the user cost of the i^{th} asset at time t and F_t is the total expenditure on financial assets.[1] Weak sustainability[2] is satisfied if there exists a subutility function V such that $U(\boldsymbol{x1}, \boldsymbol{x2}) = U(\boldsymbol{x1}, V(\boldsymbol{x2}))$ where $\boldsymbol{x1} = \{x_1, x_2, ..., x_{m\text{-}1}\}$ and $\boldsymbol{x2} = \{x_m, x_{m+1}, ..., x_n\}$ which has the same solution as maximisation problem in (1) and the elasticities of substitution among assets in $\boldsymbol{x2}$ are independent of price effects on assets in $\boldsymbol{x1}$.

We address the two issues by implementing an algorithm developed by Varian, following Afriat (1967), for testing the revealed preference theorem. Afriat's axioms are as follows:

a) The data satisfy the axiom of transitivity, i.e., $\pi^r x^r \geq \pi^r x^s$, $\pi^s x^s \geq \pi^s x^t$, . . ., $\pi^q x^q \geq \pi^q x^r$, implies $\pi^r x^r = \pi^r x^s$, $\pi^s x^s = \pi^s x^t$, . . ., $\pi^q x^q = \pi^q x^r$, where $\pi^r = (\pi_{1t}, \pi_{2t}, . . . \pi_{nt})$ for i = 1, ... n. k is the number of assets and n is the number of observations. This is also known as the Generalised Axiom of Revealed Preference (GARP)
b) There exists a utility function U^i and marginal utility $\lambda^i \geq 0$, i = 1,..., n such that $U^i \leq U^j + \lambda^i \pi^i (x^i - x^j)$, for i, j = 1,... n
c) There exists a nonsatiated, continuous, monotonic, concave utility function that rationalizes the data

[1] User cost of a financial asset is its relative opportunity cost of forgoing a benchmark asset, supposed to be bearing the highest return among all the assets. The computation of *real* user costs is mentioned later in this paper.
[2] A utility function $u(\boldsymbol{x})$ is *weakly separable* in the arguments $\boldsymbol{x}$ (= $(\boldsymbol{a}, \boldsymbol{b})$) if there is a subutility function $u_o(\boldsymbol{b})$ and a macro function $u^*(\boldsymbol{a}, u_o(\boldsymbol{b}))$ which is continuous and monotonically strictly increasing in $u_o(\boldsymbol{b})$ and $\boldsymbol{a}$, such that $u(\boldsymbol{x}) = u^*(\boldsymbol{a}, u_o(\boldsymbol{b}))$ (Swofford and Whitney 1994).

Afriat shows that if conditions a) or b) are satisfied, then the data can be rationalized by a utility function.[3]

For revealed preference to hold the following two conditions should be satisfied:

i) x^i is directly[4] revealed preferred to $\boldsymbol{x}$, written as $\boldsymbol{x^i}\ R^d\ \boldsymbol{x}$, if $\boldsymbol{\pi^i x^i} \geq \boldsymbol{\pi^i x}$

ii) x^i is revealed preferred to $\boldsymbol{x}$, written as $\boldsymbol{x^i}\ R\ \boldsymbol{x}$, if $\boldsymbol{\pi^i x^i} \geq \boldsymbol{\pi^i x^j}$, $\boldsymbol{\pi^j x^j} \geq \boldsymbol{\pi^j x^k}$, ..., $\boldsymbol{\pi^m x^m} \geq \boldsymbol{\pi^m x}$ for some sequence of observations ($\boldsymbol{x^i, x^j, .., x^m}$)

R is the transitive closure of R^d. A data set satisfies GARP if $\boldsymbol{x^t}\ R\ \boldsymbol{x^s}$ implies $\boldsymbol{\pi^s x^s} \geq \boldsymbol{\pi^s x^t}$ for all t and s. Therefore, to check for the consistency of the observed data with GARP (and thus with utility maximization), we need to check if there exists such a relation. Checking for the consistency of rationalizing behaviour enables one to find a transitive closure. Varian suggests a way of doing this by setting up a matrix of order T by T where each element is either 1 if $\boldsymbol{x^t}\ R^d\ \boldsymbol{x^s}$ is true for all t, s or 0 otherwise. This method has often been proved to be less computationally burdensome than finding solutions to the inequality relations $U^i \leq U^j + \lambda^i \pi^j (x^i - x^j)$.

Weak separability test

Suppose that the utility function $U(\boldsymbol{x})$ over financial assets is weakly separable in the assets $\boldsymbol{x} = (x_1, x_2, ... x_n)$. Suppose $x_{m+1}, x_{m+2}, ..., x_n$ are separable within the n assets $x_1, x_2, ... x_n$ so that the weakly separable utility maximization problem of the assets can be written as:

$$\begin{aligned} &\text{Max}\, U(\mathbf{a},\mathbf{b}) \ = \ U(\mathbf{a}, V(\mathbf{b})) \\ &\text{subject to}\, \mathbf{p'a} + \mathbf{r'b} \ = \ Y \end{aligned} \qquad (2)$$

where $\boldsymbol{p}$ and $\boldsymbol{r}$ are the respective user costs of the vector of assets $\boldsymbol{a} = (x_1, x_2, ..., x_{\boldsymbol{m}})$ and $\boldsymbol{b} = (x_{m+1}, x_{m+2}, ..., x_n)$ and Y is total financial expenditure. Here $V(\boldsymbol{b})$ is a subutility function in $\boldsymbol{b}$ and the elasticities of the assets in the vector $\boldsymbol{b}$ are independent of any changes in the prices of the assets in the vector $\boldsymbol{a}$.

We now need to ascertain whether the functions V and, later U, hold under the conditions of Afriat's equivalent relations. The inequality relations for which we need to find the solutions are:

[3] Checking for condition b) is more burdensome as we need to solve a linear programming problem with $2n$ variables and n^2 constraints. Varian's algorithm checks the transitivity condition.

[4] $\boldsymbol{x^i}$ is strictly directly revealed preferred to $\boldsymbol{x}$, written as $\boldsymbol{x^i}\ R^s\ \boldsymbol{x}$, if $\boldsymbol{\pi^i x^i} > \boldsymbol{\pi^i x}$.

$$
\begin{aligned}
&U^i \le U^j + \lambda^j \mathbf{p}^j(\mathbf{a}^i - \mathbf{a}^j) + \frac{\lambda^j}{\mu^j} r^j (V^i - V^j) \\
&V^i \le V^j + \mu^j r^j (\mathbf{b}^i - \mathbf{b}^j)
\end{aligned} \tag{3}
$$

for positive values of λ and μ. If there is a solution to these inequality relations, then the observed data can be rationalized by a concave, monotonic, and non-satiated utility function. Further, the function is weakly separable in the variable ***x*2**. Varian (1985, 1996) suggests a two-stage procedure to check for weak separability. First we conduct the GARP test for the groups of assets under study. Once GARP is satisfied, we can consider that group as a single asset whose value is *V* and whose price is $1/\mu$,. These magnitudes can be computed using an algorithm due to Varian (1982). Now taking this asset as a single commodity and clubbing the rest of the assets together, we conduct the GARP test again. If both tests are satisfied we can say that the data can be rationalized by a well-behaved weakly separable utility function. However, this condition is only necessary but not sufficient as Varian (1985) and Barnette and Choi (1989) point out.

Swofford and Whitney (1994) establish the sufficient conditions for weak separability to hold, given Varian's Inequalities (3). Their methodology is equivalent to finding a solution to the following minimization problem:

$$
\begin{aligned}
&\text{Min } F = \sum (\tau^j - \mu^j \varphi^j)^2 \\
&\text{sub to} \\
&U^i \le U^j + \tau^j \mathbf{p}^j (\mathbf{a}^i - \mathbf{a}^j) + \varphi^j (V^i - V^j) \\
&V^i \le V^j + \mu^j \mathbf{r}^j (\mathbf{b}^i - \mathbf{b}^j)
\end{aligned} \tag{4}
$$

There are two interpretations of the possible results to this non-linear programming problem (4):

a) if a feasible solution to this problem exists, then preferences are weakly separable in the assets in *V*
b) if a feasible solution exists and the objective function is minimized to zero, then preferences are weakly separable and adjustment is complete within each period.

To test the necessary and sufficient conditions for weak separability we implement the Swofford and Whitney (1994) model.

III. Empirical Results

We use data on financial assets from the *RBI Handbook of Statistics on the Indian Economy 2001, CD Rom*. The assets considered are a) currency, b) net deposits, c) shares and debentures, d) net claims on government, e) insurance funds, and f) provident funds. We convert (nominal values of) the assets into per capita terms by dividing the total value of each asset by the Indian population aged 15 and above for each year. The data set on population is collected from the *IFS: IMF* and spans the period from 1970 to 1998. The *real* user costs and total expenditures are computed in a manner consistent with Barnett (1978) and Anderson et al. (1997). Thus we have a series of 6 assets in per capita terms with their respective normalized real user costs normalized by total expenditure on the assets. We then test the GARP model to this data series using Varian's software routine.

Testing for GARP

We find that the data can be rationalized by a utility function and some weak separability tests are satisfied. The results are outlined in Table 1.

Table 1 here.

Table 1 gives all possible combinations of the preference structures where GARP is consistent with the given data. The U_i denote preference structures for asset *i*. The *U* in any column indicates that the particular asset in that row is included in the overall utility function whereas a *V* indicates that the particular asset in the row is included in the subutility function as a result of the weak separability tests. The *Y*'s indicate that the preference structure satisfies the necessary condition for weak separability and is consistent with GARP. Table 1 is constructed only for those preferences, which satisfy GARP and Afriat's inequalities.

The first column of Table 1 reveals that the data are consistent with GARP and hence can be rationalized by a well-behaved utility function. The second column reveals that contractual savings (assets 5 (LIC) and 6 (PPF)), i.e., the insurance funds and provident funds (broadly contractual savings) are weakly separable from the rest of the assets.[5] Other separability possibilities are indicated in the remaining columns.

[5] This would imply a preference structure of the forms U_2 where U_2 = *U*(*CUR, DEP, SHDB, CLAIM, V*(*LIC, PPF*)). As indicated below we discover that U_2 is consistent with the Swofford and Whitney (1994) necessary and sufficient conditions for weak separability. Since there is no subutiity function in structure

Any violation of GARP can be due to two reasons (i) measurement error or (ii) non-optimising behaviour of the observed data (Varian 1983). Further, the chances of violating GARP using the non-parametric approach may vary with change in the size of the data set. Hence, it is essential to ascertain the sensitivity of the GARP test to changes in the data set. Afriat (1967) constructed an efficiency index to compute the required increase in the expenditure of good *i* so that it is revealed preferred to good *j*. Thus we say that an observation *r* is directly revealed preferred to an observation *s* at efficiency level *e* if $e\, p^r x^r \geq p^r x^s$.[6] $e = 1$ is the standard revealed preference case and $e = 0$ is vacuous. For a given *e* we can construct the analogue of the direct revealed preference measure, compute its transitive closure, R_e and then check the analogue of $GARP_e$: if $x^s R_e x^t$, then $e\, p^t x^t \geq p^t x^s$.

We use *Mathematica* package to find Varian's (1982) transitive closure. From the transitive closure, we calculate Afriat's index satisfying the above relations. Table 2 gives the values of Afriat's index (for 10 consecutive points) under the assumption that the utility function is U_2. This reveals that the choices are 99% efficient with normalized user cost or real user cost in the preference structure U_2. In sum we pass GARP test comfortably for all the six assets together. We also find that there are solutions of *U* and λ which satisfy the Afriat inequalities, which is another condition of checking for GARP. So whether by transitive closure or by the Afriat's inequalities, we conclude that the observed data is consistent with GARP and hence there exist a utility function, which can rationalize the data.

However, checking for the consistency of the GARP and hence Afriat's efficiency index is not a sufficient condition for a preference structure to be weakly separable. To test for this we use the methodology of Swofford and Whitney (1994). This method of checking both the necessary and sufficient conditions is preferable to Varian’s (1985) test since the latter is not only computationally burdensome, but also solutions to the Varian’s inequalities may not be found if the level of the total financial expenditure is not optimal which, in turn, may reject the weakly separable condition. Swofford and

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U_1 the space in its weak separability row is left blank. The *U* and λ computed from Afriat's inequality suggest that the preference structure U_2 is quite consistent over time.

Whitney's (1994) model has the added advantage of permitting incomplete adjustment of expenditure among the various financial assets in response to a shock to user price (say an interest rate deregulation).

Table 2 here.

The financial data are used to find solutions to the non-linear optimisation problem (4). We use a GAMS non-linear programming procedure to solve the problem. In the non-linear optimisation, with 29 observations, the number of variables comes to 5*29 = 145 whereas the number of constraints they have to satisfy is very large (2*29*28 = 1,624). Since a solution to the non-linear programming problem (4) is a necessary and sufficient condition for weak separability test, we examine solutions to (4) in relation to the preference structures in Table 1.

We found many of them violate constraints or are unable to give any solutions. The only result that is consistent and is validated by a solution to (4) is the preference structure $U_2 = U(CUR, DEP, SHDB, CLAIM, V(LIC, PPF))$. Since the value of the minimand (4) goes arbitrarily close to zero, we conclude that there was complete adjustment. Since the solutions are consistent with the GARP test, we can claim that the preference structure U_2 satisfies the necessary and sufficient condition for weak separability and represents the preferences of a representative individual making decisions on financial assets. The fact of weak separability of this utility function would enable one to construct a suitable financial aggregate for the Indian economy.

IV. Conclusions

This paper has conducted a nonparametric test to examine the possibility of rationalizing Indian financial demand data by a utility function. The parametric test has the disadvantage that in some cases it is not possible to distinguish between a rejection of the functional form from a rejection of weak separability. We are able to independently test whether the available data on financial assets can be rationalized by a well-behaved function and then test for weak separability. In this paper we have used the algorithm developed by Varian (1985) for testing the revealed preference theorem, which provided only the necessary condition. Therefore we further examined the sufficiency condition by searching for the existence of solutions to the inequality relations put forward by

[6] Although Afriat does not require it, we adopt the convention that it is always the case that $x^r R^D x^r$; i.e., an

Swofford and Whitney (1994). Not all preference structures, that have passed the GARP tests, have solutions to the relevant non-linear programming problem. However, one result that is borne out is that the preference structure has a sub-preference in that contractual savings (insurance and provident funds) can be separated out. This would facilitate construction of a suitable financial aggregate using these assets.

observation is always directly revealed preferred to itself.

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Table 1: Results from revealed preference tests

Preference Structure	U_1	U_2	U_3	U_4	U_5	U_6	U_7
CUR	*U*	*U*	*U*	*U*	*U*	*U*	*U*
DEP	*U*	*U*	*U*	*U*	*U*	*V*	*V*
SHDB	*U*	*U*	*U*	*V*	*V*	*V*	*V*
CLAIM	*U*	*U*	*V*	*V*	*U*	*U*	*V*
LIC	*U*	*V*	*V*	*V*	*V*	*V*	*U*
PPF	*U*	*V*	*V*	*V*	*V*	*U*	*U*
Test Results							
GARP	Y	Y	Y	Y	Y	Y	Y
Afriat's inequalities	Y	Y	Y	Y	Y	Y	Y
Weakly Separability		Y	Y	Y	Y	Y	Y

Table 2: Afriat's index number

0.7500
0.8750
0.9375
0.9687
0.9844
0.9921
0.9960
0.9980
0.9990
0.9995

Note: The Afriate's index ***e*** after 10 consecutive points did not improve beyond 0.995